Detection of Sprague Dawley Sperm Using Matching Method

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Abstract. Cross correlation algorithm is the common method for image matching technique. In this paper, an expert system based on cross correlation is designed to reduce the workload of pathologist and improve the screening technology in medical field. The system is proposed to detect, locate and classify between normal and abnormal sperm head by evaluating the similarity between two images. Using cross correlation, the highest value near to one is defined as the best matching value. When this condition is obeyed, the system shows the matched image at the output together with the matching indicator. Such result indicates this system is very helpful to pathologist.

Keywords: Template matching, correlation, normal and abnormal head sperm.

1 Introduction

During the last decades, there were a lot of errors occurred in pathology field reported especially on the detection method [1,3]. One of the reasons is the excessive workload of pathologist. Pathologist needs to determine certain criteria from samples for a limited time and eventually could produce errors from their careless or in other words, the increasing pathologist workload can be correlated with the frequency of errors [1,4].

The workload of a pathologist is considered high and a lot of energy and time is needed. For example, pathologists who work with sperm samples taken from Sprague Dawley rat need to determine and classify between the normal and abnormal sperms from the screening process. Each sperm appeared on the slide is classified and counted into different classes. This screening process covers the whole area on the slide. In getting the result, pathologists do this screening process including counting and classifying sperm manually. The work consumes lots of focus, energy and consistency in order to get the accurate results. Therefore, an expert system on Sprague Dawley sperm detection is designed to replace and reduce the workload of pathologist. The system will automatically classify and count the total number of normal and abnormal sperms.

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Template matching often used in image analysis, computer vision and pattern recognition [5-7]. In image processing field, template matching is one of the most basic techniques and has also been used for many years and proposed to be one of the easiest methods in image matching research [8]. In template matching method, at least 2 images would be needed. One image is defined as a template or reference image and the other one as an input image. The operation concept of template matching is the input image is matched over the reference image [9-11]. Therefore, the reference image always has same or smaller size compared to the input image [9-12]. In the matching process, the reference image is shifted and overlapped on the input image until the whole area on the image is covered and processed.

Recently, template matching for non rigid image had received more attention and popular for research study [13,14]. In some cases, the shape and orientation of the researched image is not in great condition such as our image sample where few criterias need to be considered before the matching process can be applied.

2 Rat Sperm Morphology

Sperm samples, randomly taken from the Sprague Dawley rat had been used as research samples. The head of sperm is approximately 2.5µm long [2]. For a normal sperm, the head resembles a hook, therefore any other shapes are classified as abnormal sperm. The head contains nucleus operates as main controller of each sperm. The morphology of a normal rat sperm is given in Figure 1 [2].

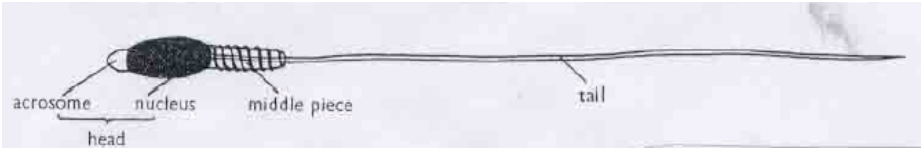

Fig. 1. The morphology of rat sperm

The system is designed to operate under magnification of 40x. During observation accurate result could be achieved when the processed image is magnified at 40x. Therefore, each image sample had been captured under magnification 40x correlated with the system designed. The normal spermatozoon after magnification at 40x is shown in Figure 2.

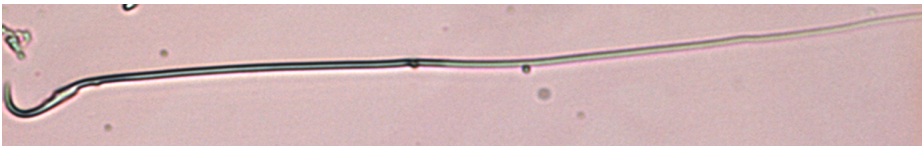

Fig. 2. The normal spermatozoon magnification at 40x

3 Template Matching Using Correlation

Template matching is one of the most common methods for similarity finding. To use this method, some of the important criterias need to be analyzed prior to get the best matching result. The important criteria need to be considered are the size of the image, orientation and the pixel intensity [5, 7, 8, 14, and 16]. In this research, matching is used as the main method to find the similarity between two images. Some other important methods have also been used in getting the best matching result such as segmentation, filtering and counting.

For segmentation method, grey-level value of data image was used in separating process [15-17]. Then it will differentiate the sperm and its background automatically. Segmentation method is used to eliminate the useless information pixel by setting them into certain pixel intensity [7,18].

For template matching technique, correlation method was being used. The result of the matching process lies in range 0 to 1 which indicates 0% and 100% matching percentage respectively. The result is in integer. When the result is near to 0, the matching percentage is near to 0% which proving no matching between both images. Using the same concept, when the result shows any integer near to 1, both images processed is almost similar or 100% match [7-9, 15, 18]. In statistics, correlation terms sometimes used to refer the covariance between two factors, such as to find the correlation between these 2 factors in their relationship. The higher correlation between these factors, the stronger relation between them.

For the research implementation, we used 2 dimensional cross correlation in template matching technique. The 2 dimensional cross correlation equation is shown in equation 1[9-11,19].

$$\text{Out}(i, j) = \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} \text{In1}(m, n)\, \text{In2}(i + m, j + n)\,. \tag{1}$$

Where In1 and In2 are the input images and Out is the result of the cross correlation between In1 and In2. In1, In2 and Out are in 2 dimensional image. In1 operates as the main image and In2 as the template images. The size of template image is usually smaller than the main image [9-12]. In the matching process, template image can be described as reference image. Template image is matched and shifted with the main image until it finds the highest matching percentage between both images. This process is repeated until all area on the main image is overlapped by the template image.

4 Result and Discussions

The system is designed to evaluate the input image and classify into two main classes which are known as normal and abnormal sperms. Template image is saved as the reference data. This reference data is chosen from the finest shape of normal sperm

samples. Firstly, the system runs and saves the template data into one data array and then it becomes reference image for all input images. Secondly, the input images are segmented into binary form automatically and the resultant image displayed only in white and black pixels. Segmentation method is used to separate the sperm image from its background. Black pixel is the sperm image and white pixel is its background. The reference image is shown in Figure 3.

Fig. 3. The reference image for the system

The size of the reference image is 69 x 71 pixels. The black pixel shows the head of normal sperm and it cut from its tail to result accurate matching calculation.

For pre processing, the input image must undergo segmentation process to differentiate between the head sperm and its background. Filtering is then applied to decrease the amount of noises in the input image. Some of the resultant images are shown in Figure 4, 5 and 6 for Image01, Image02 and Image03 respectively.

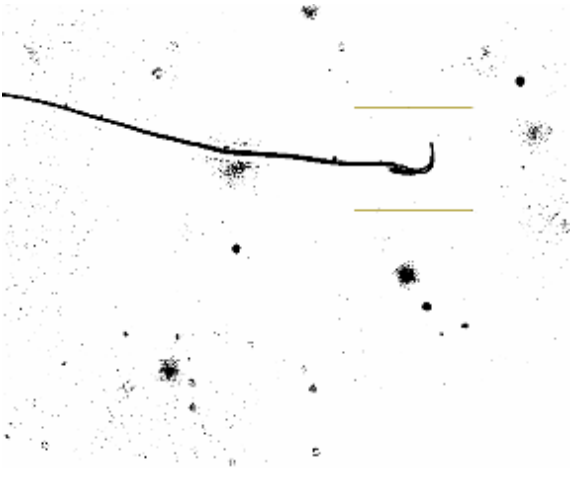

Fig. 4. The output Image01 with indicator

Figures 4, 5 and 6 show 2 lines at the top and the bottom of the head sperm to indicate the matching image (i.e. the sperm head) in the system. In this study, 50 random head sperm images had been tested and the result is tabulated in Table 1.

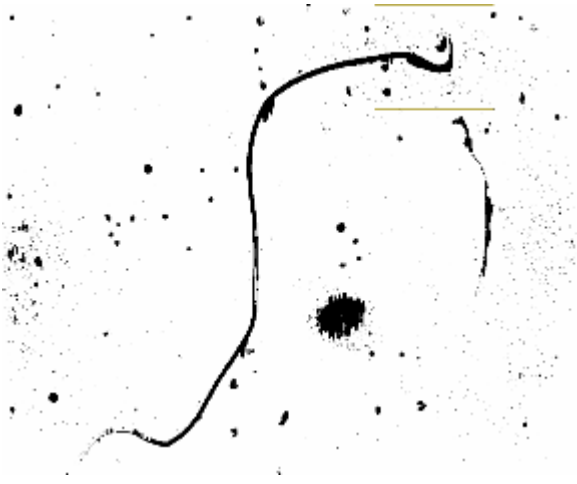

Fig. 5. The output Image02 with indicator

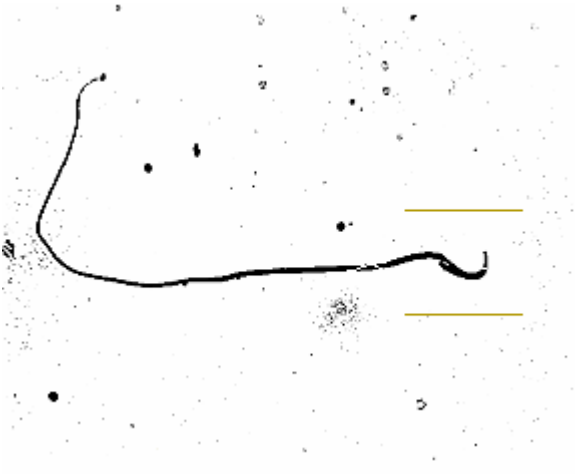

Fig. 6. The output Image03 with indicator

Table 1. Matching percentage of 50 input images

	Matching Percentage (%)					
	Above 70	Above 75	Above 80	Above85	Above90	Above95
Total number of correct detection	50	48	40	33	24	16
Percentage of correct detection	100%	96%	80%	66%	48%	32%

From Table 1, 100% of accuracy is achieved when the system considers the sperm head is correctly detected if 70% of area of the tested sperm image is matched with the reference sperm head image. 96% of tested images are correctly determined if the matching percentage is set to 75% and above. The system has also shown a high capability of detecting the sperm head by producing high accuracy although the matching percentage is increased. The system is capable to achieve the accuracy up to 80%, 66%, 48% and 32% for the matching percentage set to above 80, above 85, above 90 and above 95 respectively. The results obtained prove that the proposed system is suitable and high capability to be used as detection system for Sprague Dawley Sperm.

5 Conclusions

In this research, a system is designed to reduce the workload of the pathology. By using the best and suitable method, the system can be proven to reduce the workload of pathologist thus save more time. In this study, an expert Detection of Sprague Dawley Sperm system has been proposed to detect and classify the normal and abnormal sperm. The system requires 2 input images in applying the cross correlation method. Each image operates as main and template image respectively. The template image is set to be the reference image. The matching process is repeated until the whole area on the main image is covered. Some of pre processing methods are used in helping to get the best matching output such as segmentation, region growing and filtering. When the matching condition is obeyed, the system shows an indicator for the matched head sperm on the input image as the output display. As conclusion, this project has successfully carried out its objectives. The proposed template matching method performs promising assistant for pathologist and the matching accuracy is totally reliable for this project. More research needs to be done in this field to make the system more robust and be trusted 100% by consumer.

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